

# Sepsis

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## Introduction

Sepsis is a systemic inflammatory response secondary to an infection that has caused the release of inflammatory mediators into the bloodstream. The sepsis syndrome is a clinically defined continuum which includes Systemic Inflammatory Response Syndrome (SIRS), sepsis (SIRS plus infection), severe sepsis (sepsis plus organ dysfunction), and septic shock (severe sepsis plus hypotension refractory to fluid resuscitation). Despite the best of terrestrial care, mortality is still often high.<sup>[1]</sup>

Although pre-launch medical screening and crew quarantine greatly reduces the risk of crewmembers launching with an infectious condition, infections may be acquired during the mission. Studies have shown that space flight causes an immune system dysregulation, which may increase the risk for infections in crewmembers during the flight.<sup>[2]</sup> Sepsis is life-threatening, and should be treated promptly to avoid loss of crew life.

## Clinical Priority and Clinical Priority Rationale by Design Reference Mission

*One of the inherent properties of space flight is a limitation in available mass, power, and volume within the space craft. These limitations mandate prioritization of what medical equipment and consumables are manifested for the flight, and which medical conditions would be addressed. Therefore, clinical priorities have been assigned to describe which medical conditions will be allocated resources for diagnosis and treatment. “Shall” conditions are those for which diagnostic and treatment capability must be provided, due to a high likelihood of their occurrence and severe consequence if the condition were to occur and no treatment was available. “Should” conditions are those for which diagnostic and treatment capability should be provided if mass/power/volume limitations allow. Conditions were designated as “Not Addressed” if no specific diagnostic and/or treatment capability are expected to be manifested, either due to a very low likelihood of occurrence or other limitations (for example, in medical training, hardware, or consumables) that would preclude treatment. Design Reference Missions (DRMs) are proposed future missions designated by a set of assumptions that encompass parameters such as destination,*

length of mission, number of crewmembers, number of Extravehicular Activities (EVAs), and anticipated level of care. The clinical priorities for all medical conditions on the Exploration Medical Condition List (EMCL) can be found here ([https://humanresearchwiki.jsc.nasa.gov/index.php?title=Category:All\\_DRM](https://humanresearchwiki.jsc.nasa.gov/index.php?title=Category:All_DRM)). The EMCL document may be accessed here ([https://humanresearchwiki.jsc.nasa.gov/images/6/62/EMCL\\_RevC\\_2013.pdf](https://humanresearchwiki.jsc.nasa.gov/images/6/62/EMCL_RevC_2013.pdf)).

Design Reference Mission	Clinical Priority	Clinical Priority Rationale
<p>Lunar sortie mission</p> <p>Assumptions:</p> <ul style="list-style-type: none"> <li>4 crewmembers (3 males, 1 female)</li> <li>14 days total</li> <li>4 EVAs/ crewmember</li> <li><u>Level of Care 3</u></li> </ul>	Shall	Sepsis is life threatening, and should be treated promptly to avoid loss of crew life. Therefore, treatment capability shall be manifested.
<p>Lunar outpost mission</p> <p>Assumptions:</p> <ul style="list-style-type: none"> <li>4 crewmembers (3 males, 1 female)</li> <li>180 days total</li> <li>90 EVAs/ crewmember</li> <li><u>Level of Care 4</u></li> </ul>	Shall	Sepsis is life threatening, and should be treated promptly to avoid loss of crew life. Therefore, treatment capability shall be manifested.
<p>Near-Earth Asteroid (NEA) mission</p> <p>Assumptions:</p> <ul style="list-style-type: none"> <li>3 crewmembers (2 males, 1 female)</li> <li>395 days total</li> <li>30 EVAs/ crewmember</li> <li><u>Level of Care 5</u></li> </ul>	Shall	Sepsis is life threatening, and should be treated promptly to avoid loss of crew life. Therefore, treatment capability shall be manifested.

## Initial Treatment Steps During Space Flight

A link is provided to a prior version of the International Space Station (ISS) Medical Checklist, which outlines the initial diagnostic and treatment steps recommended during space flight for various conditions which may be encountered onboard the ISS. Further diagnostic and treatment procedures beyond the initial steps outlined in the

*Medical Checklist are then recommended by the ground-based Flight Surgeon, depending on the clinical scenario. Please note that this version does not represent current diagnostic or treatment capabilities available on the ISS. While more recent versions of this document are not accessible to the general public, the provided version of the checklist can still provide a general sense of how medical conditions are handled in the space flight environment. Medical Checklists will be developed for exploration missions at a later point in time.*

Please note this file is over 20 megabytes (MB) in size, and may take a few minutes to fully download.

ISS Medical Checklist ([http://www.nasa.gov/centers/johnson/pdf/163533main\\_ISS\\_Med\\_CL.pdf](http://www.nasa.gov/centers/johnson/pdf/163533main_ISS_Med_CL.pdf))

## Capabilities Needed for Diagnosis

*The following is a hypothetical list of capabilities that would be helpful in diagnosis. It does not necessarily represent the current capabilities available onboard current spacecraft or on the ISS, and may include capabilities that are not yet feasible in the space flight environment.*

- Vital signs measurement capability (blood pressure, pulse, respiratory rate, temperature, pulse oximetry, as required per the patient's clinical state)
- Auscultation device (such as a stethoscope)
- Cardiac [Electrocardiograph (ECG)] monitor
- Imaging (such as X-ray, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), ultrasound)
- Laboratory testing [blood analysis, blood gases, urinalysis, gram stains, and cultures of blood, sputum, urine, and cerebrospinal fluid (CSF)]

## Capabilities Needed for Treatment

*The following is a hypothetical list of capabilities that would be helpful in treatment. It does not necessarily represent the current capabilities available onboard current spacecraft or on the ISS, and may include capabilities that are not yet feasible in the space flight environment.*

- Central Venous Pressure (CVP)
- Pulmonary Artery Occlusion Pressure (PAOP)
- Pulse oximetry
- Blood gases
- Blood analysis
- Urine outputs
- Foley catheter
- Urimeter bag
- Crew medical restraint system

The other part of the treatment is interventional and includes:

- Skin cleanser (such as alcohol/Benzalkonium antiseptic (BZK)/iodine)
- Bandaging
- Intravenous (IV) start and administration kit (rapid access may be needed)
- Intravascular volume replacement (such as IV fluids)
- IV pump or pressure infuser
- Tape
- Non-sterile gloves
- Sharp container
- Antibiotics [Intramuscular (IM), IV]
- Vasopressors (if hypotensive)
- Supplemental oxygen
- Ventilator
- Intubation kit
- Deep vein thrombosis (DVT) prophylaxis
- Gastrointestinal (GI) ulcer prophylaxis

## Associated Gap Reports

*The NASA Human Research Program (HRP) identifies gaps in knowledge about the health risks associated with human space travel and the ability to mitigate such risks. The overall objective is to identify gaps critical to human space missions and close them through research and development. The gap reports that are applicable to this medical condition are listed below. A link to all of the HRP gaps can be found here (<http://humanresearchroadmap.nasa.gov/Gaps/>).*

- 2.01 - We do not know the quantified health and mission outcomes due to medical events during exploration missions.
- 2.02 - We do not know how the inclusion of a physician crew medical officer quantitatively impacts clinical outcomes during exploration missions.
- 3.01 - We do not know the optimal training methods for in-flight medical conditions identified on the Exploration Medical Condition List taking into account the crew medical officer's clinical background. (Closed)
- 3.03 - We do not know which emerging technologies are suitable for in-flight screening, diagnosis, and treatment during exploration missions.
- 4.01 - We do not have the capability to provide a guided medical procedure system that integrates with the medical system during exploration missions.
- 4.02 - We do not have the capability to provide non-invasive medical imaging during exploration missions.
- 4.04 - We do not have the capability to deliver supplemental oxygen to crew members while minimizing local and cabin oxygen build-up during exploration missions.
- 4.05 - We do not have the capability to measure laboratory analytes in a minimally invasive manner during exploration missions.
- 4.09 - We do not have the capability to provide medical suction and fluid containment during exploration missions.
- 4.12 - We do not have the capability to generate and utilize sterile intravenous fluid from potable water during exploration missions.
- 4.14 - We do not have the capability to track medical inventory in a manner that integrates securely with the medical system during exploration missions.
- 4.15 - Lack of medication usage tracking system that includes automatic time stamping and crew identification
- 4.17 - We do not have the capability to package medications to preserve stability and shelf-life during exploration missions.

- 4.19 - We do not have the capability to monitor physiological parameters in a minimally invasive manner during exploration missions.
- 4.23 - We do not have the capability to auscultate, transmit, and record body sounds during exploration missions.
- 4.24 - Lack of knowledge regarding the treatment of conditions on the Space Medicine Exploration Medical Condition List in remote, resource poor environments (Closed)
- 4.27 - We do not have the capability to sterilize medical equipment during exploration missions.
- 5.01 - We do not have the capability to comprehensively manage medical data during exploration missions.

## Other Pertinent Documents

## List of Acronyms

<b>B</b>	
<a href="#">BZK</a>	Benzalkonium antiseptic
<b>C</b>	
<a href="#">CSF</a>	Cerebrospinal Fluid
<a href="#">CT</a>	Computed Tomography
<a href="#">CVP</a>	Central Venous Pressure
<b>D</b>	
<a href="#">DRM</a>	Design Reference Mission
<a href="#">DVT</a>	Deep Vein Thrombosis
<b>E</b>	
<a href="#">ECG</a>	Electrocardiograph
<a href="#">EMCL</a>	Exploration Medical Condition List
<a href="#">EVA</a>	Extravehicular Activity
<b>G</b>	
<a href="#">GI</a>	Gastrointestinal
<b>H</b>	
<a href="#">HRP</a>	Human Research Program
<b>I</b>	
<a href="#">IM</a>	Intramuscular
<a href="#">ISS</a>	International Space Station
<a href="#">IV</a>	Intravenous
<b>M</b>	
<a href="#">MB</a>	Megabyte
<a href="#">MRI</a>	Magnetic Resonance Imaging
<b>N</b>	
<a href="#">NASA</a>	National Aeronautics and Space Administration
<a href="#">NEA</a>	Near Earth Asteroid

<b>P</b>	
<a href="#">PAOP</a>	Pulmonary Artery Occlusion Pressure
<b>S</b>	
<a href="#">SIRS</a>	Systemic Inflammatory Response Syndrome
<b>U</b>	
<a href="#">U.S.</a>	United States

## References

1. Dellinger RP, Levy MM, Carlet JM, et al. Surviving Sepsis Campaign: International Guidelines for the Management of Severe Sepsis and Septic Shock: 2008. Crit Care Med. 2008; 36(1):296-327.
2. Sams CF, Pierson DL. Immunologic Concerns. In: Barratt M, Pool S, editors. Principles of Clinical Medicine for Space Flight. New York: Springer; 2008. P307-315.

## Last Update

This topic was last updated on 8/13/2014 (Version 2).

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